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The molluscan taxocoene of differently-exposed *Cymodocea nodosa* beds: year-long structural patterns and sampling methods

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KEY WORDS: Molluscs, Community structure, Sampling methods, Seagrass ecology.

ABSTRACT The structural changes during one year in the mollusc taxocoene living in two differently-exposed *Cymodocea nodosa* beds of the island of Ischia (Gulf of Naples - Italy) are discussed. The efficiency of two sampling devices, the hand-towed net and the suction sampler, is also compared.

Higher values of abundance and species richness are recorded throughoutthe year in the sheltered bed, which is characterized by a well-developed turf and a high density of shoots. In both beds, year-long trends of basic community parameters show maxima during the summer and minima during the winter, as the does density of plant cover.

The suction-sampler collects more species and more individuals, al though it covers a smaller surface than the hand-net. This device is also more effective at sampling molluscs from both the leaves and the sediment at the base of the plant, while the hand-net collects almost exclusively the malacofauna living an the leaf stratum.

From a bionomic point of view, the *Cymodocea* system seems to be more than a simple *facies* of one of the coenotic units with which it has been associated.

RIASSUNTO Vengono discussi i dati relativi alla distribuzione ed alla composizione della componente malacologica di due siti limitrofi dell'isola d'Ischia caratterizzati da praterie di *Cymodocea nodosa* differentemente strutturate.

I campionamenti sono stati effettuati tra l'estate del 1988 e quella del 1989, con cadenza bimestrale ed utilizzando due differenti atttezzi di campionamento, il retino manovrato a mano e la sorbona.

Il contributo maggiore, sia in termini quantitativi che qualitativi, è stato fornito dai campioni di sorbona con il 79% del totale degli individui, appartenenti a 38 specie.

La differenza tta le strutture dei popolamenti delle due stazioni considerate è piuttosto marcata. In particolare, indipendentemente dai metodi di campionamento adottati, la stazione con il prato a maggiore densità risulta essere caratterizzata da un numero sia di specie che di individui di gran lunga maggiore rispetto all'altra.

Il trend stagionale è piuttosto evidente in entrambi i siti, con valori massimi di abbondanza e ricchezza specifica durante il periodo estivo e valori minimi in inverno. Tale andamento generale è evidente soprattutto nei campioni di retino e, in particolare, in quelli del prato meno denso, in cui è minore la presenza di specie tipiche del substrato e, quindi, il taxocene risulta dipendere maggiormente dalla densità dello strato foliare, molto variabile durante l'anno.

I dati ottenuti sembrano suggerire una maggiore efficienza della sorbona, che campiona ugualmente bene sia lo strato foliare sia il substrato alla base delle piante. Tuttavia, soprattutto in estate, con il massimo sviluppo dello strato foliare, il campionamento con retino, particolarmente efficiente per questo strato, potrebbe fornire informazioni complementari sulla struttura complessiva dell'associazione malacologica.

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INTRODUCTION

Along the coast of the Mediterranean Sea, *Cymodocea nodosa* (Ucria) Aschers. is the most common and widespread seagrass, together with *Posidonia oceanica* (L.) Delile. The former generally occurs in shallow (not more than 5-6 m deep) sandy-muddy bottoms, characterized by sheltered conditions, as in the case of closed bays, ports and lagoons. However, *Cymodocea* beds have recently also been reported along open coasts, but on bottoms of greater depth (from 5 to about 20m deep) (BUIA *et al.* 1985a; GIANGRANDE & GAMBI, 1986).

The rhizomes and the root system of *Cymodocea* form a complex interlaced structure called 'turf'. This structure stabilizes the soft bottom and is well developed in sheltered conditions, where it may be over 20 cm thick (BUIA *et al.*, 1985b) lying a few centimeters under the surface of the sediment (Fig. 1).

Early studies considered the *Cymodocea* bed to be a seral stage of succession, as it is thought that it prepares the soft bottom for colonization by the *Posidonia* prairie, which represents the *climax* ecosystem in the coastal areas of the Mediterranean (MOLINIER & PICARD, 1952; DEN HARTOG, 1977). However, recent evidence seems to support the theory that the two seagrasses are independent as concerns substrate colonization (BOUDOURESQUE *et al.*, 1989). Likewise, contrasting opinions have been put forward regarding the benthic fauna associated with *Cymodocea nodosa* plants. There are doubts as to whether these associations of organisms have a coenotic identity or whether they are simply facies of other biocoenoses. Some authors (e.g. PÉRÈS & PICARD, 1964) consider the animal associations occurring on soft bottoms covered by *Cymodocea* as just "*facies a épiflore*" of the coenotic unit of 'well-sorted fine sands' (French acronym, SFBC). On the other hand, LEDOYER (1966) emphasized that the vagile fauna living in the foliar stratum of *Cymodocea* beds give rise to what may be considered an impoverished *facies* of the *Posidonia oceanica* coenotic unit. In any case, data are

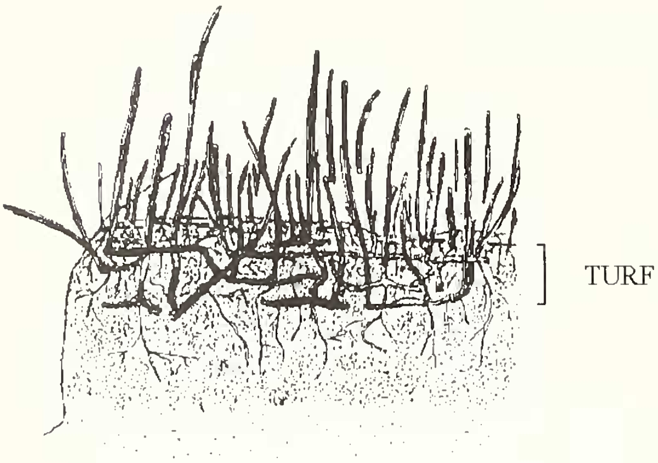

Figure 1. The Stagnone di Marsala lagoon with the stations of sampling (1-6).

rather scarce and mainly concern the variability of the association in space (Dieuzeide & Goeau-Brissonniere, 1951; Ledoyer, 1962; 1966; 1968; Harmelin & Schlenz, 1963), even though *Cymodocea* beds show a strong seasonality, in terms of growth rate and plant density (Buia *et al*, 1992). As regards Italian coasts, synecological studies have been conducted only for polychaetes (Giangrande & Gambi, 1986; Lanera & Gambi, 1993; Gambi & Bremec, in press).

The methods used to sample the vagile fauna from the *Cymodocea* seagrass beds are mainly the hand towed-net and the suction-sampler (or air-lift), which are the same as those adopted for the fauna of *Posidonia*. However, unlike that dotained for the latter seagrass (e.g. Russo *et al.*, 1985; RUSSO & TERLIZZI, this issue), no comparative information is available on the efficiency of sampling gears in collecting the different faunistic components of *Cymodocea* beds.

The aim of the present paper is, firstly, to shed light on the structure and the year-long dynamics of the mollusc taxocene living in two differently-exposed *Cymodocea* beds and, secondly, to compare the information on the taxocoene dotained using the two sampling methods mentioned above.

METHODS

Sampling sites

Two *Cymodocea nodosa* beds facing San Pietro beach along the northern coast of the island of Ischia (Gulf of Naples) were studied (Fig. 2a). They colonize adjacent soft bottoms (at a depth range of 0.5-4.5 m) separated by a rocky artificial barrier (Fig. 2b). The presence of the barrier influences the characteristics of the two beds: one of the in station 1 was foundto be very sheltered, being characterized by muddy-sandy sediments and a well developed 'turf', while the other (st. 2) is more exposed, being characterized by sandy sediments without the presence of 'turf'. In the sheltered bed (station 1) seagrass density(shoots/m^2) ranges from approximately 1100 (November-May) to 2300 (July-September), while it ranges from approximately 550 (May) to 950 (September) in the exposed bed (Figs 2 and 3). In the *Cymodocea nodosa* bed with 'turf', the co-occurrence of the seagrass *Zostera noltii* contributes to approximately 30% of the high density values for the bed (Buia *et al.*, 1985 b).

Collecting methods and data analysis

In both sites, sampling was performed bimonthly during the course of a year (July 1988 - May 1989), at a depth of 2.5 m. Vagile fauna was collected by SCUBA divers using two different techniques: (a) a hand-towed net, over a surface of about 20 m^2 (Russo & Vinci, 1991), and (b) a suction-sampler, over a surface of 1 m^2 (Russo *et al.*, 1986).

Molluscs were sorted and identified following Sabelli *et al.* (1990). The descriptive analysis was carried out taking into account the presence of species and their relative and absolute abundances in the samples. A comparison of the results obtained using the two collection methods in the different beds allowed a preliminary evaluation of their efficiency with respect to the different mollusc species.

In order to identify coenotic patterns on a temporal scale, a structural comparison of the malacological associations was performed starting from a matrix of raw data and using the multivariate ordination technique of correspondance analysis (CA) (Pielou, 1984). The significance of the axes was tested according to the method proposed by Frontier (1974).

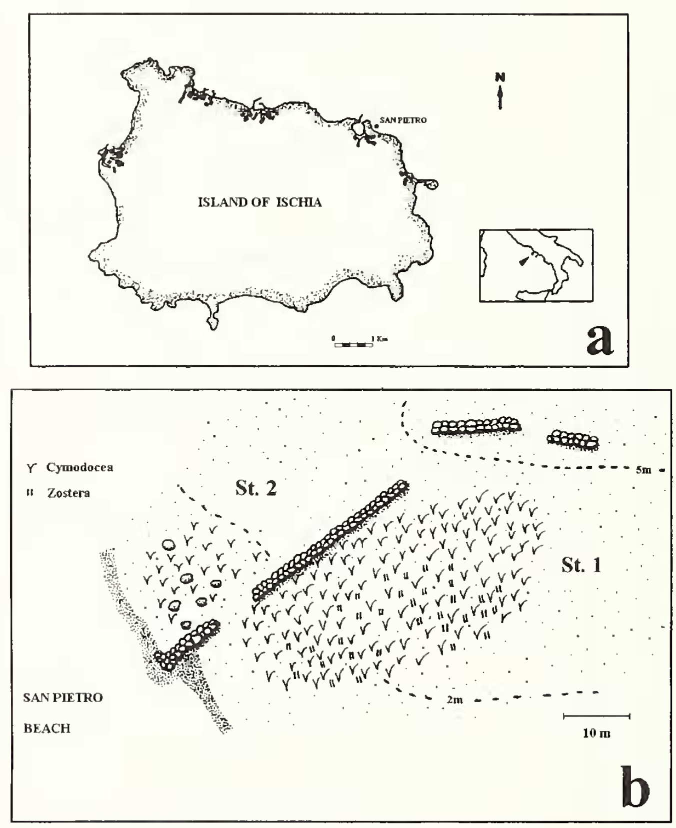

Figure 2. The hydrodinamic model of surface currents (from Di Pisa & Riggio, 1982, slightly modified).

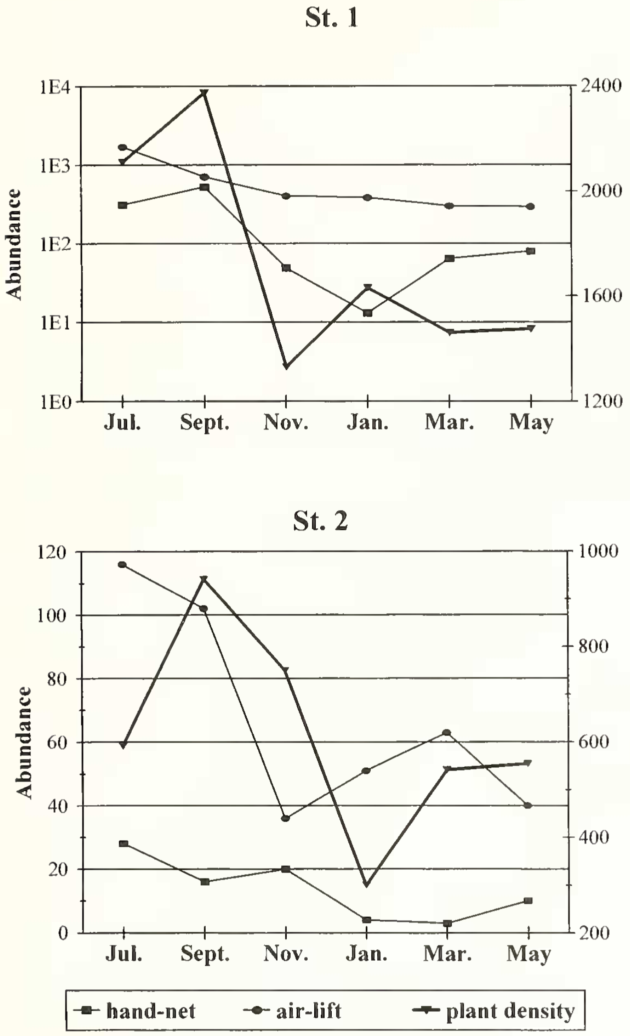

Figure 3. Rarefaction curve of sampling area/number of species ratio.

RESULTS

Descriptive analysis

Sampling yielded 5318 Mollusc individuals of, 3623 Gastropods (68%) and 1695 Bivalves (32%). Of these, 4191 (79%) were collected by suction sampler and 1127 (21%) by hand towed net. In both stations, and in every month, the air-lift collected more individuals than the net, despite the fact that the former sampled from a much smaller area (1m2) than the latter (about 20 m2) (Fig. 2).

The species with the highest abundance values were, from the gastropods,and *Bittium reticulatum* (2811; 53%) *Jujubinus gravinae* (293 ind.; 5.5%). As for the bivalves high abundance values were obtained by *Loripes lacteus* (1398; 26%).

Different time-trends of abundance values wereobserved in the samples collected by the two sampling methods (Fig. 3). Regarding data obtained by air-lift, in both stations the values remained quite constant during the year, with higher values during summer and a slight decrease in November. However, a difference of one order of magnitude was faund between the abundances recorded in station 1 (about 1000 individuals) and station 2 (about 100 individuals). As for the data obtained by hand-net, the values were more variable, showing a remarkable decrease during the winter. Also using the hand-net, there was a difference of one order of magnitude between the abundances recorded for station 1 (hundreds) and those recorded for station 2 (tens). The two stations reached their minimum abundance in different months: January and March.

In totals 42 species were sampled, 28 Gastropods (67%) and 14 Bivalves (33%). Of these 42 species, 19 (45%) were collected using both methods (e.g. *Bittium reticulatum*, from the gastropods, and *Loripes lacteus*, from the bivalves), 20 (48%) were exclusively present in the samples collected by air-lift (e.g. *Nassarius reticulatus*, from the gastropods, and *Tellina tenuis*, *Paphia rhomboides* and *Chamelea gallina*, from the bivalves) and just 3 (7%) were exclusively present in the samples collected by hand-towed net (the gastropods *Tricolia speciosa*, *Rissoa variabilis* and *Rissoa violacea*). As abundance, species richness was also higher in the samples collected by air lift than in those collected by net, in both stations and in every month (except station 1 in September; cfr. Fig. 4).

In both stations, samples collected by hand-net had smaller fluctuations in species richness during the year than those collected by air-lift. In the latter case, lower values were recorded in November and higher values in March; secondary peaks occurred in July (station 1) and September (station 2).

The efficiency of the two tools at collecting species was variable during the year but thesuction-sampler always collected more exclusive species than the hand-net (Fig. 5). The number of species collected by both methods was higher in station 1 than in station 2. Species which were exclusive to the hand-net were completely lacking in January (station 1) and March (both stations), while they were quite abundant in July (station 2) and September (station 1).

Structural analysis

After the elimination of 9 'singletons', a first raw data matrix of dimensions 34 x (2 x (2x6)) (i.e. species x (stations x (sampling methods x months))) was obtained. The matrix was utilized to obtain a CA ordination model in which the first two factors were significant. However, the distribution of the 24 sample-points on the plane described by the factors was difficult to interpretate as too many sources of variability were present together in the starting matrix. Therefore, as a second step, two matrices of (species x (methods x months)), i. e. each containing the data of a single station, were utilized separately in the multivariate analysis.

The CA ordination model of the samples collected from station 1 was obtained from a 29 x (2 x 6) matrix of raw data and is shown in Fig. 6. Only the first factor of the model was significant (F1= 48.8%; F2= 17.7% of the total variance). Along the axis expressed by this factor, two main patterns of sample-points may be observed. First, points are clustered according to the collecting method, as most of the samples by air-lift have negative values of saturation (only two have low positive

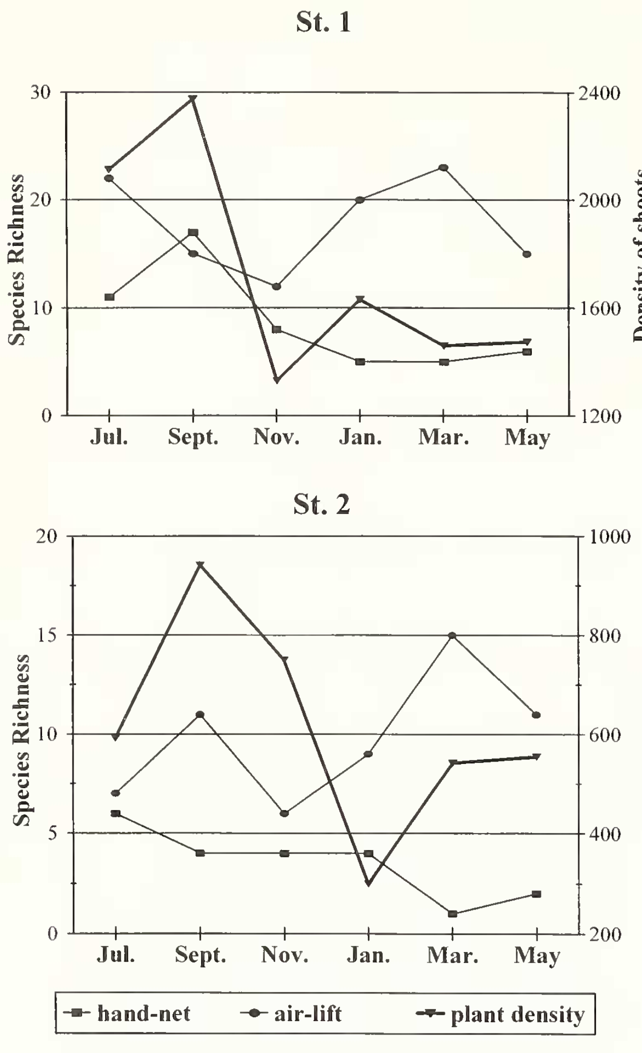

Figure 4. Distribution of the sampled species in orders.

values), while those by hand-net are strongly polarized in the positive portion of the axis. Second, the distribution of sample-points into each cluster is well related to their time-position along the year cycle, describing the consistent temporal drift of the station. In particular, in the cluster related to the hand-net (N), increasing saturation values are associated with the samples of January (1N), March (3N), May (5N) and July (7N); a strong discontinuity is evident between the samples of July (7N) and September (9N), showing a marked decrease in the value of saturation. As for the cluster related to the air-lift, a marked discontinuity between samples of the cold season (1S, 3S, 9S, 11S) and those of the warm season (5S, 7S) is evident.

The CA ordination model of the samples collected from station 2 was obtained from a 22 x (2 x 6) matrix of raw data and is shown in Fig. 7. Only the first axis of the model is significant (F1= 40.3%; F2= 14.6% of the total variance). Also in this model sample-points are clustered along the first axis according to the collecting method, as samples by air-lift have negative values of saturation, while those by hand-net are distributed in the positive portion of the axis (with the exception of 3N). As for the distribution of sample-points in each cluster (temporal drift of the station), the discontinuity between May (5S) and July (7S) in the cluster of samples by air-lift, and the strong polarization of September (9N) and especially November (11N) in the group of samples by hand-net should be noted.

DISCUSSION

The two *Cymodocea nodosa* beds showed remarkable differences in the structure of their mollusc taxocoene. Basic community parameters, such as abundance and species richness, have much higher values in the more dense bed (station 1), where a well-structured turf was present, than in the other bed (station 2).
Seasonal trends in qualitative and quantitative community parameters were fairly clear, but were differentdepending on the sampling method used and the bed structure. In both stations, high values of species richness during winter (January- March) are associated with taxocoene living in the substrate (sandy sediment turf) which is better sampled by air-lift. As has also been pointed out for *Posidonia oceanica* beds (Terlizzi & Russo, 1996), the greater effectiveness of the suction-sampler could be due to a lower 'obstruction effect' caused by leaves, which are less dense in this period.

High values of species richness during summer (July-September) are due to the important contribution of snails living in the leaf stratum (e.g. *Trochidae* and *Rissoidae*) when the density of the beds reaches a maximum. In this period the community parameters recorded by hand-net, which are strongly related to leaf cover, also reach their maxima, while the minima are recorded in winter (January-March). Descriptive analysis and the ordination model show that the period of November to January seems to be critical for the structure of the beds and for the associated malacological assemblages. This may be due to the fact that, during this period storms uproot the plants, causing a strong decrease in bed density and, as a consequence, a quali-quantitative reduction in the malacofauna. This general trend is particularly evident in the more exposed bed (station 2), where the plant cover almost disappears during the winter.

As regards the two methods, they did not show marked qualitative differences in efficiency in sampling the characteristic species of the leaf stratum, although the hand net collected more individuals, as the surface sampled is greater. The suction sampler is more effective, both in qualitative and quantitative terms, at collecting species from the substrate. On the whole, the latter sampling gear is better suited to the structure of malacological associations, but in summer the hand-net may give some further quantitative information on the structure of leaf stratum taxocoenoses.

Although the mollusc association of *Cymodocea nodosa* showed several species present in the *Posidonia oceanica* leaf stratum, their total numberwas much lower. This is probably due to differences in morphology and phenology between the two plants. The smaller *Cymodocea* offers a lower degree of habitat structure than *Posidonia*. Furthermore, compared to the more stable beds of *Posidonia*, where the yearly variability in habitat structure is mainly related to changes in leaf length, *Cymodocea* beds show a

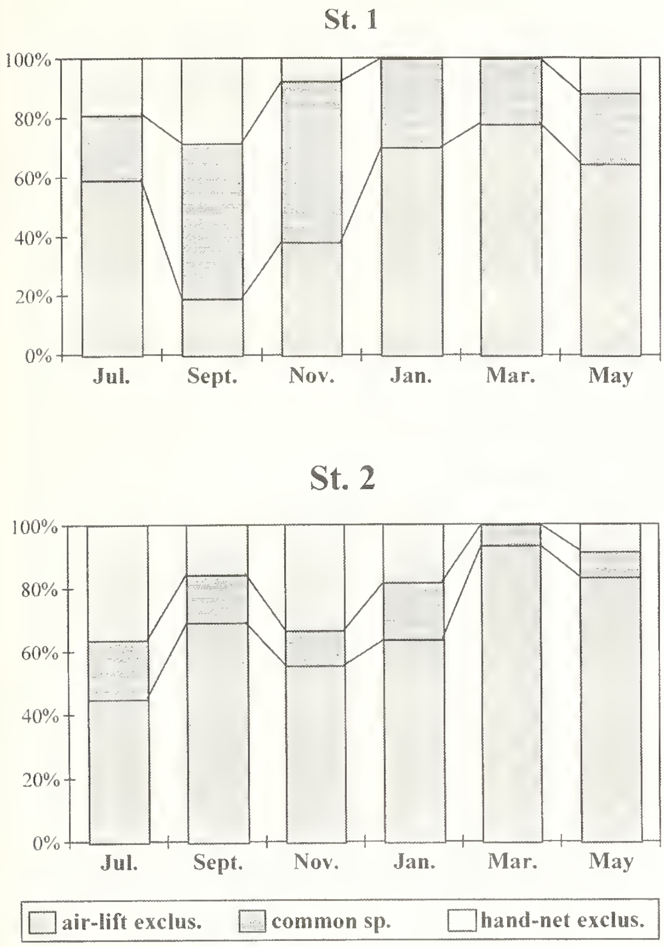

Figure 5. Shannon-Wiener diversity indices and their evenness. The open quadrats mean the values of the Shannon index while the black dots mean the relative values of the evenness.

higher degree of variability, related to the marked fluctuations in shoot density. The presence of the 'turf' (station 1) contributes to stabilizing the plant cover on the sandy bottom against uprooting by winter storms and provides for a higher faunistic diversification and a lower seasonal variability in the mollusc taxocoene.

In conclusion, the malacological association of *Cymodocea nodosa* beds considered here seems to be a component of a system which is more complex than a simple *facies* of a coenotic unit, of either enriched soft bottoms (PÉRÈS & PICARD, 1964) or of impoverished secondary hard bottoms (LEDOYER, 1966). This is particularly true in conditions which allow a more developed habitat structure (turf). In any case, this benthic system appears to have peculiar structural and functional characteristics, which make it particularly elastic.

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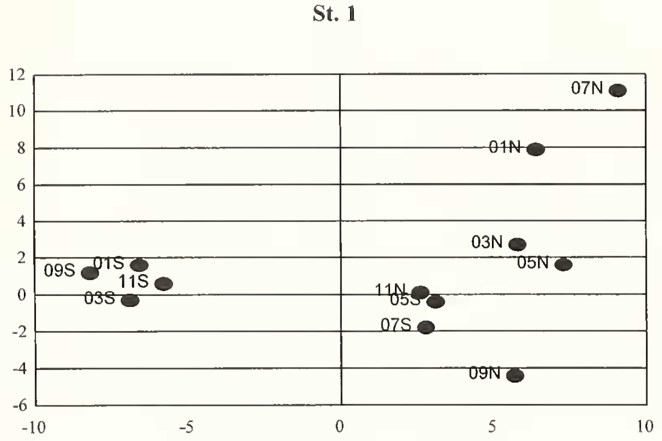

Figure 6. AC ordination model of st.1, where only the sampling-points were plotted. S=suction-sampler, N=hand-net. The number is related to the month (1=January, 3=March, 5=May, etc.).

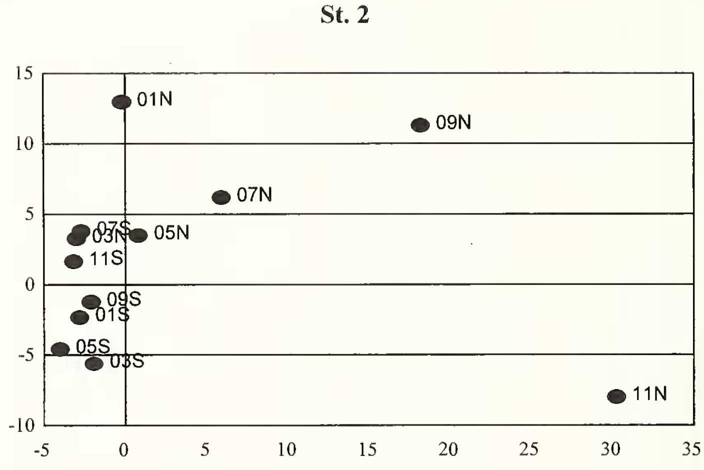

Figure 7. AC ordination model of st. 2, where only the sampling-points were plotted. S=suction-sampler, N=hand-net.
The number is related to the month (1=January, 3=March, 5=May, etc.).

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